Closing MG Steam & Condensate System on a Paper Machine

Abstract:

This paper presents how the ineffective condensate removal problem can be eliminated from the MG by closing MG steam & condensate system just by changing condensate piping of suitable size. In addition to a trouble free operation, boiler fuel saving, lower dependency of equipments, electricity saving can be achieved by directing condensate from MG directly to boiler house. In addition, a higher condensate return can be obtained by recovering flash steam fully or partially.

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Introduction:

Energy conservation has been a topic of interest for almost all involved in any type of operation due to ever increasing costs of energy and fuel. As a tool of energy conservation, system closure plays a vital role. As the paper making involves drying of paper by utilization of latent heat content available in steam, the condensate is generated. The purpose to recover the condensate generally is to reuse heat content available in it, but, as a solution to a different problem, it has been found that the condensate can be transferred more efficiently to boiler house without much effort.

Case History:

In a particular case, it was observed that in a waste paper based mill, steam consumption in hydrapulping or pulp mill-stock preparation section was virtually nil. All the steam was being used only for paper machine. Once again, in absence of any flow meter, a time totalizer was connected with the only boiler feed pump and a daily reading was taken used to get the total run hours of boiler feed pump, which multiplied with the pump flow rate gives steam consumption. Analyzing the pump running hours on a daily basis, it was found that the boiler feed pump run hours could be considered to be good indicative of steam consumption.

Since the beginning, the mill faced a problem of frequent vibrations in MG and MG framings due to improper water removal from MG. After frequent problems, it was thought that only one steam trap of 2” size was inadequate and another trap of same size was installed in parallel to the previous one. The problem reduced significantly, but still appeared almost every fortnight. Then alongwith inverted bucket type, thermodynamic traps were also installed thinking that the bucket might be stuck to the body of trap. The problem remained the same. Finally, a bypass line was provided without any steam trap to condensate tank (Open to atmosphere), so that in case any problem appears, the machine personnel may empty out MG with that line. But, by this time the machine personnel were so frightened of the problem that they made it a habit to use the bypass line always open to condensate tank. This resulted in heavy steam losses and the steam consumption increased by around 15-25% in a month as significant quantity of steam was now being released to atmosphere along with condensate.

Action Taken:

To analyze the problem, data was collected on MG pressure during different conditions. It was observed that the pressure remained at around 2.8 Kg/cm^2g during normal operation. During short breaks at wire, or MG-pope reel, the pressure remained nearly the same as the duration of the break was of the order of 1-4 minutes. For relatively longer breaks or small shuts of 15-45 minutes, such as quality change, system washing, wire & felt cleaning, the pressure was kept at around 1-1.5 bar. For longer shuts such as clothing change, monthly maintenance shut etc. the pressure was reduced down to zero, but such instances were only just a couple or so per month.

On the basis of above data it was thought if we could supply condensate directly to the boiler house by means of pressure inside MG, saving on following points could be achieved-

1. No breakdown due to MG hammering due to improper removal of condensate.
2. No need of Condensate pump (3 HP) – a saving of around RS. 180/- per day.
3. No wastage of flash steam near machine house resulting in boiler feed water temperature increase by around 20 C, approximating a saving of around RS. 250/- per day.
4. No moving parts in the system, (pumps, steam traps etc.) hence no maintenance.

Now, the steam flow rate was computed by multiplying boiler feed pump running hours with pump flow capacity. With this value, the condensate flow velocity was calculated. It was observed that the nominal speed was of the order of 0.2 m/s only in a 2" pipeline. In order to increase the flow velocity so that the pressure drop in the line increases, and hence steam flashing is reduced, the pipeline diameter was reduced to 20 mm ID only for a length of around 2 Mts. The purpose of smaller pipe section was to ensure that pressure drop across complete pipeline is lower, while, only a narrow path is available for the condensate and steam thus ensuring lower steam losses. This line was then directed to boiler feed water tank. The steam losses were found to be reduced drastically after this scheme was implemented. At first time, when the machine was started after a long shut of a few days due to some other reason, improper condensate removal was observed initially due to low MG pressure. Hence a

bypass line was fitted in order to drain the condensate during startups. This line was used for nearly one hour during startup, and as soon as the MG pressure reached to normal value, condensate was directed to boiler directly. The total investment incurred for the modification of pipelines, giving extra valves, labour for fitting work etc. was calculated to be of the order of RS. 4000/- only. Furthermore, as fitted earlier, three steam traps were freed from the system, which could be used elsewhere, if required.

Steam Wastage from Proposed System:

One may question the utility of proposed system that in absence of any steam trap, a lot of steam will be wasted. It was tried to evaluate the quantity of maximum possible steam wastage by the proposed method. The following assumptions are being taken:

Diameter of pipeline:	20 mm
Steam pressure inside MG	2.8 Kg/cm^2
Steam velocity in the pipeline	20 m/s
Volumetric flow rate of steam	3.14 * 0.02 * 0.02 * 20 / 4 m^3/sec.
	= 0.00628 m^3/sec
	= 22 m^3/hr
At 2.8 Kg/cm2g, specific volume	0.49 m^3/Kg
Steam Flow Possible in the line	22/0.49 Kg/Hr.
	= 44 Kg/Hr.

If the normal steam consumption is of the order of 2200 Kg/hr, the maximum possible steam loss accounts for a maximum of 2%. Furthermore, as proposed hereunder, instrumentation can be used to reduce these losses to zero.

Instrumentation:

Many mills may like to add instrumentation to such systems. A logic has been developed for incorporation of the instrumentation for automatic control of condensate flow to the boiler house.

1. A pressurized condensate tank is used to receive all condensate from MG. This tank is connected without any inlet valve.

2. At the bottom of tank a pipeline is connected which transfers the condensate to boiler house. The pipeline is so designed that the condensate flow rate in the line is of the order of 2-3 m/s. This is done to ensure that only condensate with no or very less steam is sent to boiler house.
3. The above pipeline has a control valve which controls the level in the tank using lever transmitter and a controller. If the level is high, the control valve is opened, and if the level is low, the control valve opening reduces.
4. Another ON/OFF type drain valve (solenoid valve) is fitted in the bottom of tank that opens up if either the level is higher than alarm value or the pressure is below a critical value at which condensate ceases to flow to boiler house.
5. A manual drain valve is provided in the tank for draining this tank during emergency. Safety valve of course is not very much needed, as in this tank; pressure cannot be more than MG pressure. Still, if desired so, a safety valve may be given.

Earlier, it was decided to observe the performance of above system for a few months, before investing for the instrumentation as discussed above. Later on when it was found that no MG hammering was observed after modification in condensate piping, even in two years. Again steam consumption did not increase using above system, the installation of instrumentation was ruled out and decided to let system work as it is. It was also noted that using the above system, the boiler feed water temperature that remained to the tune of 60 deg. Centigrade, could be increased to 95 deg. Centigrade. In this way, no steam was required to further heat up the condensate.

Installation of Heat Exchanger:

To further increase the condensate return, it was planned to install a heat exchanger in the condensate line. This heat exchanger acts as heat exchanger as well as a condenser. The fresh water is passed through the heat exchanger and hot water coming out of heat exchanger is used for different purposes, within the plant. The amount of flash vapors can be calculated as under-

Steam Pressure in MG:	2.8 Kg/cm^2
Condensate Pressure:	2.8 Kg/cm^2
Condensate Enthalpy:	141.8 Kcal/Kg
After flashing, condensate enthalpy	99.2 Kcal/Kg
Flash Vapor enthalpy:	638.8 Kcal/Kg
Flash Vapors generated	(141.8-99.2)/(638.8-99.2)

= 0.0789 Kg/Kg steam
= 8%

By installing the heat exchanger, condensate return was increased by 8%, obviously, as more condensate was being available, the blow down could be reduced significantly without any problem. Even if the gains due to application of hot water in different applications are ignored, the reduced blow downs make the investment very much viable with a payback period of a few months. The above systems have been discussed in figures 1,2, and 3 given at the end of this paper.

Overall Benefits:

By the proposed work, the following benefits were observed-

1. The MG hammering problems were completely eliminated. Hence down time due to above problem was reduced by 100%.
2. Steam consumption was reduced by nearly 5%.
3. Condensate return was increased to 92-95%.
4. Blow downs were drastically reduced.
5. Hot water became available for pulp mill and paper machine showering purpose, using the waste heat with flash steam.
6. Application of boiler descaling chemicals was completely eliminated.
7. If there is some air present inside MG, heat transfer is reduced drastically. This air also restricts to flow of condensate through steam trap. With the system discussed above, such possibilities are completely eliminated, and even the production can be increased to certain extent.

Conclusion:

After modification in condensate piping, and installation of heat exchanger, condensate return about 95% could be achieved. After successful operation for a long time, it is now clear that the best way for condensate removal to let it flow without any restriction.

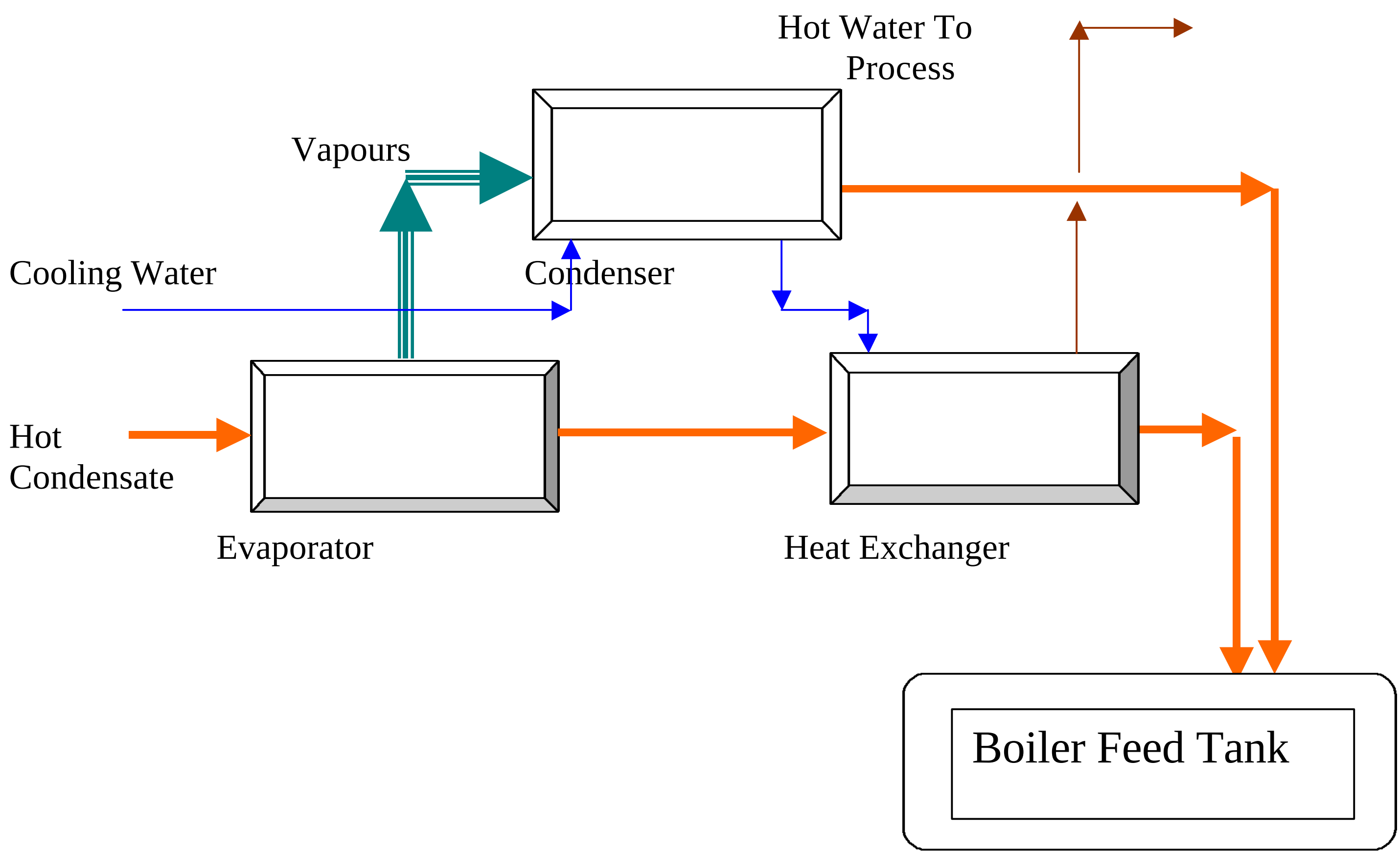

Fig. 1: System for Improving Condensate Return

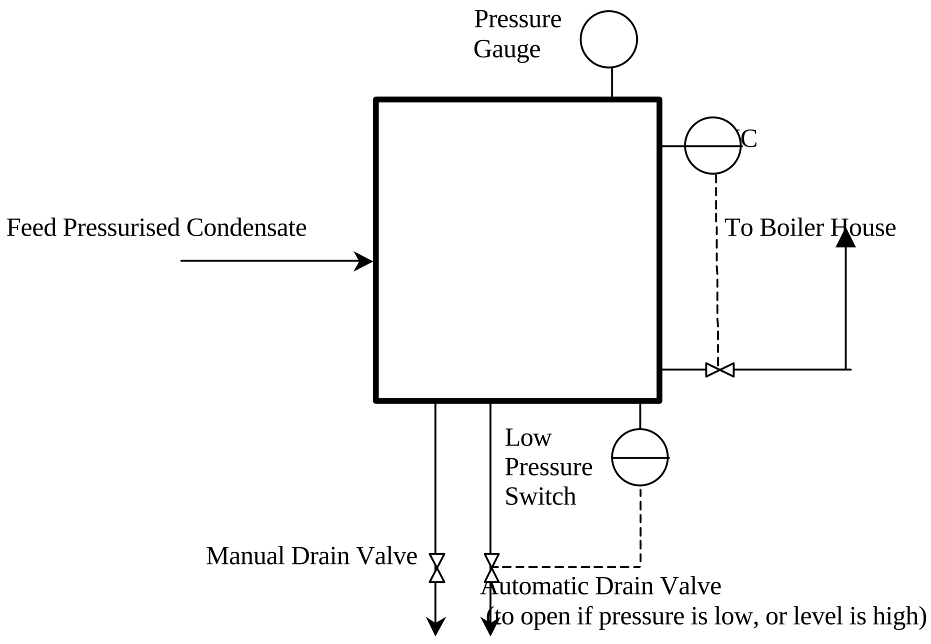

Fig. 2: Instrumentation Schematic for Direct Condensate Transfer

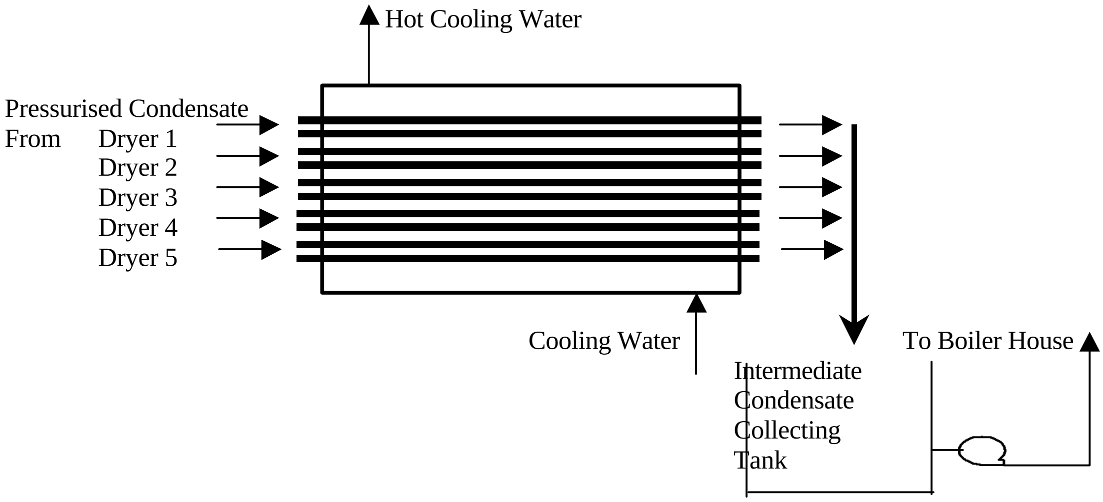

Fig. 3: Heat Exchanger for Condensate Heat Recovery for Multiple Dryers